THE EFFECT OF CERIUM ON MAGNETIC PROPERTIES OF THE ALNICO ALLOYS*

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Investigations have shown that an addition of 0.15% Ce to the Alnico alloy containing 34% Co and 5% Ti heightens magnetic properties and improves the grindability of the alloy.

1. Introduction

The improvement of technological and physical properties of steels and alloys is also possible by addition, during the steelmaking process, of small amounts of various elements which act as deoxidizing and modifying agents.

It is a well known fact that niobium [1, 2], hafnium [1, 3] and samarium [4] have a beneficial influence on the magnetic properties of alloys of the Alnico type containing 4—8% Ti, causing a significant increase of the coercive force H_c and of maximal magnetic energy $(BH)_{max}$.

The objective of this work has been the examination of the effect of addition of cerium on magnetic properties of an Alnico alloy containing 34% Co and 75% Ti.

2. Experimental procedure, material preparation and measurements

(a) Melting and teeming

The melting of an Alnico alloy of the chemical composition: 7.5% Al, 15% Ni, 34% Co, 5% Ti, 3%Cu, from 0 to 0.25% Ce and the rest Fe was carried out in a Balzer 5 kg vacuum induction furnace with a magnesite crucible. The materials used were of a chemical purity ranging from 99.9 to 99.99%. Throughout the heating the pressure in the furnace laboratory was reduced to 1.3×10^{-2} N/m^2. In order to eliminate the oxidation of various components of the alloy the teeming was conducted in an atmosphere of pure and dry argon at reduced pressure.

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(b) Heat treatment

After heat treatment in a magnetic field an alloy of Alnico type acquires anisotropic magnetic properties. The heat treatment applied during the investigations, which consists of:

1. homogenizing at 1523 K for 30 min.,
2. solution heat treatment — air-cooling from 1523 to 1083 K and isothermal holding at 1083 K for 12 min. followed by subsequent cooling to the ambient temperature. In the temperature range from 1173 to 873 K, an external magnetic field of 312 kA/m was applied,
3. ageing in two stages, the first at a temperature of 923 K for 6 hrs, and the second at 823 K for 24 hrs.

(c) Measurements of magnetic properties

After the final heat treatment, demagnetizing curves were measured and B_r, H_c and $(BH)_{max}$ were determined in $30 \times 15 \times 15$ mm samples using AEG type M4 double armature.

3. *Results of investigations*

The dependence of coercive force, of magnetic flux density and of maximal magnetic energy in the Alnico alloy on the proportional content of cerium is presented in Fig. 1. As can be deduced from the diagrams, with the increase of cerium content up to 0.15% there is an improvement in the magnetic properties of the alloy, but these properties

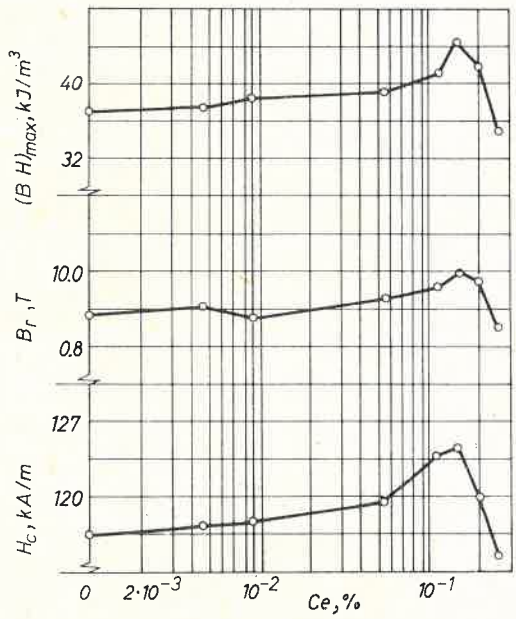

Fig. 1. Influence of cerium on the magnetic properties of Alnico (34% Co, 5% Ti) alloy

begin to determinate if the cerium content exceeds this value. With an addition of 0.15% of cerium, the maximum increase in value is: for H_c 11%, for B_r 6%, for $(BH)_{max}$ 8.6%.

In addition to the improvement of magnetic properties, an addition of cerium improves also significantly the grindability of the alloy.

At the present stage of investigations it is as yet impossible to determine accurately the true causes that make cerium influence magnetic properties of the Alnico alloy. This problem, and not only as regards cerium but also other rare earth elements, is the object of our present studies and the results of the research will be published in due course.

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